Title: Breaking the marathon world record with your father? The superpower of lifelong endurance training

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Keywords (to put in the margin):

- **Marathon race:** Long-distance road running race of 42.195 kilometres, created in 1896 for the original modern Olympic games in Athens, Greece. The official record time is owned by Eliud Kipchoge (from Kenya, Africa) in 2h01min39s, performance set on 16 September 2018 at the Berlin Marathon in Germany.
- **Maximal oxygen consumption:** also called VO_{2max}, it reflects the body's ability to take the oxygen from the air with the lungs, to transport it to the active muscles during exercise, and the capacity for the muscles to use it to produce energy. VO_{2max} is measured by using a respiratory gas analyser connected to a face mask positioned onto the athlete's mouth and nose. It is expressed in ml of oxygen inspired per kilogram of body mass per min (ml/kg/min).
- **Physical performance:** Developing the best physical performance possible is the common goal of athletes to win sporting contests and break records. It generally refers to being stronger, faster, and more resistant to fatigue.
- The age-related decline in endurance performance is about 6-10 % per decade after 40 years old.

Are you looking for a training buddy to prepare for your next marathon race? Have you ever considered that your father could be the right person? Would it not be great to cross the finish line side by side and get on the podium together? You probably think that he is not young enough for such an effort, don't you? and if I tell you that your father is also able of exceptional physical performances despite his older age. In the following article, we are going to see how a father and son (with a 25-year age difference) managed to break the world record for combined father and son marathon in 2019.

1. CAN WE MAINTAIN PHYSICAL PERFORMANCE WITH AGEING?

It is well known that **physical performance** declines with ageing. Older people tend to be slower and less powerful, and it is even worse when physical activity is reduced. Unfortunately, it is not uncommon to see the proportion of time spent watching TV or staying on the sofa, increase with ageing. This sedentary lifestyle is associated with a gradual deconditioning, due to alterations in muscular properties (muscle mass is replaced by fat), cardio-respiratory (heart and lung) and metabolic (regulation of blood sugar) functions. Consequently, muscle force and **maximal oxygen consumption** (called VO_{2max}) decline, making daily activities such as

walking or carrying objects, harder and more painful [1, 2]. If physical activity is not resumed, this lifestyle can lead to pathologies classically associated with ageing such as osteoporosis (reduction in bone mass), obesity, or cardiorespiratory failure.

On another hand, some people consider ageing differently. Masters athletes (more than 40 years of age) continue to train intensively and regularly during their entire life [3]. Some of them train even harder than younger athletes, to try to maintain their performance level as long as they can. They also take part in more and more sporting competitions such as **marathon** races and triathlons [4, 5]. Researchers have reported a steady increase in the number of masters athletes participating in sporting events in the last 30 years. For example, nowadays more than 50% of men and 40% of women at the New-York marathon or at the Ironman triathlon World championship are masters athletes [4, 5]. Masters athletes not only take part in competitions, but also manage to improve record performances in their age groups. For example, in recent years some exceptional performances have been reported on the marathon with the current world record set at 2h54min23s for the age of 70 [6]. For scientists, masters athletes represent a model of successful ageing and a valuable source of insight into human's ability to maintain physical performance with ageing [3]. In other words, studying masters athletes can help to better understand the effect of primary biological ageing (with no confounding factors like sedentary or obesity) and can help to find strategies for healthy ageing.

INSERT FIGURE 1 HERE

2. HOW DID WE STUDY THE EFFECTS OF LIFELONG ENDURANCE TRAINING?

The purpose of our research was to evaluate the physical capacities of two marathon runners, a son and his father and to follow them in their preparation for their attempt to break the world record for combined father and son marathon in Frankfurt in Germany, in October 2019. Through this comparison, we also wanted to better understand the superpower of lifelong endurance training.

The father was a former Olympic marathoner who competed at the Barcelona games in 1992. His best marathon performance was 2h13min59 set at the age of 32. At the time of the study, he was 59 and held the age-59 marathon world record in 2h30min15s. His son was 35 years

97 old and less experienced (he started to train hard only 4 years earlier) but he could run faster
98 than his father on shorter distances such as 10km and half marathon races.

99 **Phase 1.** Two months prior to the marathon, father and son visited our sport science laboratory
100 at Liverpool John Moores University (Liverpool, United Kingdom) to undertake a series of
101 physical testing. We measured their body composition (their body mass, and the proportion of
102 muscle and fat mass) using a piece of equipment called a DXA scanner. Then, after a quick
103 warm-up, they ran on a treadmill at four different submaximal speeds (15, 16, 17 and 18 km/h)
104 for 5 minutes each, speeds they could hold without difficulty. This test was useful to assess
105 their running economy, which is the amount of energy utilised by the body to run at each stage,
106 with the lower energy consumption at a given speed the better. Each running stage was
107 separated by 5 minutes of recovery to limit fatigue. After this test, the running speed on the
108 treadmill was gradually incremented every minute until volitional exhaustion of the athletes.
109 During these running tests, the athletes wore a chest belt to monitor heart rate and a face mask
110 to monitor their oxygen consumption (VO_2). When athletes reached their point of exhaustion,
111 we could determine their maximal oxygen consumption (VO_{2max}), which is like the engine
112 capacity for a car.

113 **Phase 2.** Their training routine, including the number of kilometres they ran every week, as
114 well as their dietary habits were recorded within the last two months prior to the marathon. The
115 father ran an average of 180km per week during this period of time, while it was 140km per
116 week for his son. Due to work commitment they did not usually train together, except on certain
117 occasions. Most of their training was performed at running speeds under their planed marathon
118 pace, and they reached higher speeds during local races (from 5km to half-marathon races) they
119 entered almost every weekend. Regarding their diet, father and son had the same basic diet rich
120 in carbohydrates. It was composed of porridge oats with fresh and dried fruits for breakfast, a
121 whole meal sandwich for lunch, and potatoes or rice or pasta accompanied mostly with chicken
122 for dinner.

123 **Phase 3.** On Sunday 27th October 2019, father and son participated in the Frankfurt marathon.
124 Their running pace (corresponding to their average running speed) was collected during the
125 entire marathon race using a small chip attached onto one of their trainers. We also measured
126 the number of energy bars, gels, or drinks they ingested during the marathon race.

127

128 **3. HOW DID FATHER AND SON PERFORM?**

Father and son achieved their goal by breaking the World record for combined father and son marathon by almost 3 minutes. More precisely, the father completed the marathon in 2h27min52s and his son finished in 2h31min30s for a combined time of 4h59min22s, which was 2min50s faster than the previous combined father and son marathon world record. The father also broke his own age-59 World record by 2min23s on that day.

INSERT FIGURE 2 HERE

Their exceptional performance could be explained by several factors measured during the physical tests conducted in our laboratory. During their maximal running test until exhaustion, father and son reached high VO_{2max} values compared to the average values classically reported for their age. Specifically, the father's VO_{2max} was 65 ml/kg/min while it was 67 ml/kg/min for his son. In comparison, the average value reported for people of the same age is 31 and 40 ml/kg/min, respectively, which is much lower than our athletes [7]. A high VO_{2max} is a clear asset for endurance performance and a common characteristics of elite younger endurance runners, with the best marathon runners presenting VO_{2max} above 80 ml/min/kg [8]. In addition, their running economy (oxygen uptake at marathon pace) was close to that measured in elite younger marathon runners, which means they could maintain a high running speed during the entire marathon. Both father and son presented a low body mass (61.2 and 67.4 kg for father and son, respectively) and percentage of body fat mass (10.9 % and 12.7 % for father and son, respectively) which likely contributed to their good running economy (the lower the body mass to carry, the lower the energy required to run). Our findings suggest that they could still improve their World record by optimising their nutritional strategy in race, as the father only ingested 2 energy gels (at mid-race and 32nd km) with water, while the son ingested 1 energy gel with a few sips of sports drinks. Eating plenty of carbohydrates in the forms of drinks and gels is very important during such a long race to provide a constant flow of energy to the muscles [9]. With more experience, the son could also likely improve his time with a better control of his pacing strategy over the race. Indeed, when we looked at the running speed of our two runners during the race, we noticed that the father adopted a steady running pace during the entire race, whereas it was a fast first half followed by a slower and difficult second half for the son (figure 3). Recent studies and the observation of elite athletes tell us that the best pacing strategy was that adopted by the father [10].

Beyond the combined father and son marathon world record, the most astonishing result was the exceptional performance of the father. The father crossed the finish line before his son (he finished 76th and his son 115th overall). The father could maintain an impressively high intensity during the entire marathon, despite his age. At his marathon speed, his oxygen consumption was close to ~91% of his maximal capacity. A similar capacity was also observed in the master marathon runner who currently holds the age-70 World record [6]. These values are the highest ever observed on the marathon at any age, even including elite young marathon runners. These data show that masters athletes, are able to extend the limits of human performance.

INSERT FIGURE 3 HERE

CONCLUSION

Overall, our study is the proof that masters athletes can maintain an exceptional level of physical performance, despite the ageing process. It is also important to mention that you do not need to train as much as our athletes to benefit from the superpower of physical training. However, we hope that you will bear in mind that keeping an active lifestyle and training with advancing age will help you to stay healthier for your entire life. In our study we focused on the marathon that is considered as the reference endurance event in running, and in which all age groups compete together in the same event. Future studies should focus on other types of sport such as swimming or cycling in which the body weight is borne (by water or the bike, respectively) and verify if such exceptional performances are possible.

ORIGINAL SOURCE ARTICLE

Louis, J., Bontemps, B., and Lepers, R. 2020. Analysis of the world record time for combined father and son marathon. *J. Appl. Physiol.* doi: 10.1152/japplphysiol.00819.2019

CONFLICT OF INTEREST STATEMENT: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

REFERENCES

1. Porter, M.M., Vandervoort, A.A., and Lexell, J. 1995. Aging of human muscle: structure, function and adaptability. *Scand J Med Sci Sports* 5**,** 129-142.
2. Fleg, J.L., Morrell, C.H., Bos, A.G., Brant, L.J., Talbot, L.A., Wright, J.G., and Lakatta, E.G. 2005. Accelerated longitudinal decline of aerobic capacity in healthy older adults. *Circulation* 112**,** 674-682.
3. Lepers, R., and Stapley, P.J. 2016. Master Athletes Are Extending the Limits of Human Endurance. *Front Physiol* 7**,** 613.
4. Lepers, R., and Cattagni, T. 2012. Do older athletes reach limits in their performance during marathon running? *Age (Dordr)* 34**,** 773-781.
5. Lepers, R., Rust, C.A., Stapley, P.J., and Knechtle, B. 2013. Relative improvements in endurance performance with age: evidence from 25 years of Hawaii Ironman racing. *Age (Dordr)* 35**,** 953-962.
6. Robinson, A.T., Watso, J.C., Babcock, M.C., Joyner, M.J., and Farquhar, W.B. 2019. Record-Breaking Performance in a 70-Year-Old Marathoner. *N Engl J Med* 380**,** 1485-1486.
7. Pescatello Ls, Arena R, Riebe D, and Pd., T. 2014. "ACSM's Guidelines for Exercise Testing and Prescription". 9th ed. Philadelphia (PA): Lippincott Williams & Wilkins).
8. Lucia, A., Esteve-Lanao, J., Olivan, J., Gomez-Gallego, F., San Juan, A.F., Santiago, C., Perez, M., Chamorro-Vina, C., and Foster, C. 2006. Physiological characteristics of the best Eritrean runners-exceptional running economy. *Appl Physiol Nutr Metab* 31**,** 530-540.
9. Burke, L.M., Jeukendrup, A.E., Jones, A.M., and Mooses, M. 2019. Contemporary Nutrition Strategies to Optimize Performance in Distance Runners and Race Walkers. *Int J Sport Nutr Exerc Metab* 29**,** 117-129.
10. Diaz, J.J., Fernandez-Ozcorta, E.J., and Santos-Concejero, J. 2018. The influence of pacing strategy on marathon world records. *Eur J Sport Sci* 18**,** 781-786.

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Julien is a Senior Lecturer in sport and exercise sciences at Liverpool John Moores University, in Liverpool (UK). His research aims to identify the best training, nutritional and recovery strategies for optimising sports performance from young to masters athletes.

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Bastien is a Ph.D. student in Sport and Exercise Sciences who is interested in training and recovery strategies for runners. He currently investigates the effects of specific training methods on muscle adaptations and running performance. He also studies the potential of innovative running garments (such as compression garments) to facilitate recovery from intense exercise.

ROMUALD LEPERS

I am a Professor in exercise physiology at the Faculty of Sport Sciences of Dijon, University of Bourgogne (France). My laboratory is part of the National Institute for Health and Medical Research (INSERM CAPS). I am interested in the age-related changes in endurance performance such as marathon and triathlon. I also perform research on how physical exercise affects muscular and neural systems. Outside of work, I love swimming, cycling, running, and taking part in triathlon races.

LEGENDS

244

245 **Figure 1**

246 The effects of ageing in athletes

Figure 2

Photograph of father and son crossing the finish line of the marathon.

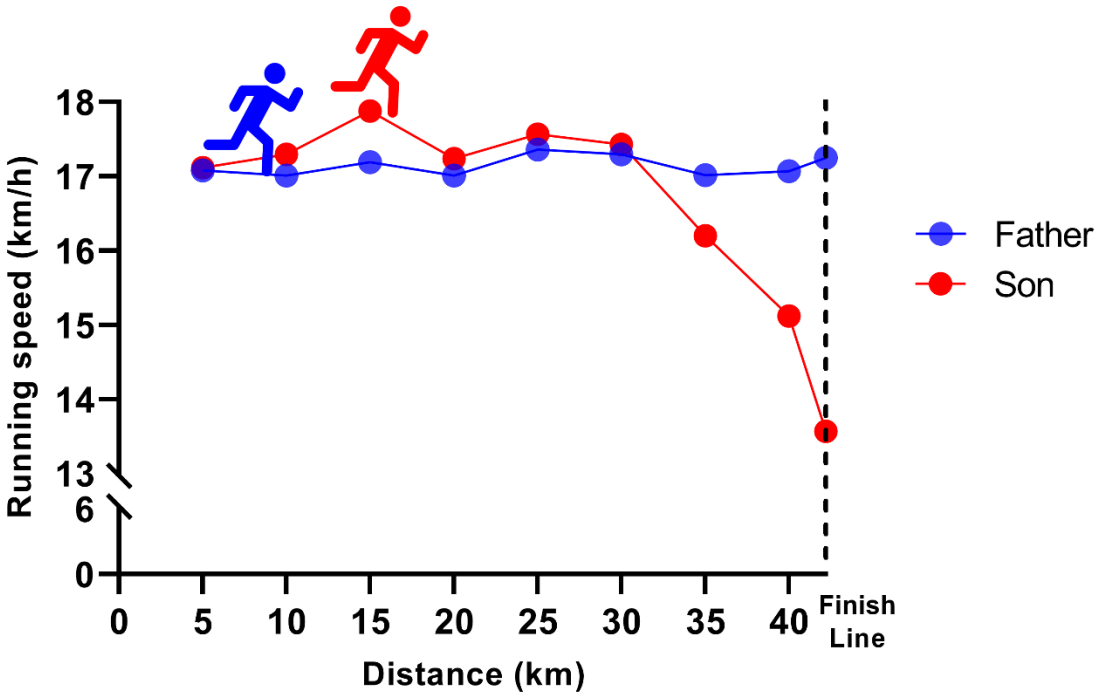

Figure 3

Pacing strategy of father (in blue) and son (in red) every 5km of the race up to the finish line. The son's running speed was slightly higher than his father up to the 30th km and then dropped massively until the end of the race. In contrast, the father maintained a steady running speed during the entire race, which allowed him to deliver the best performance on the marathon at his age.